STATIC AND DYNAMIC BEHAVIOR OF SOFT CLAY SOILS STABILIZED BY OIL PALM'S DIRTYGOLD

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Project Summary

The construction of heavy structures on soft clay soil is a high challenging task. Oil palm fuel ash (POFA) is one of the most abundantly produced waste materials which has a strong potential to treat physical and chemical characteristics of problematic soils thanks to its high siliceous content. Utilizing of this dirty gold as full or partial substitution of conventional additives in ground improvement not only can reduce the energy consumption of these additives but also can be useful with respect to reducing the waste disposal volume of landfills. This proposed research consists of four stages. The first stage investigates the efficacy of utilizing OPFA on the basic geotechnical characteristics of soft clay soils. In the second part, behavior of OPFA stabilized soft clay soils under static and dynamic load is modeled. For this purpose, geotechnical design procedure of interaction between a strip footing model and POFA stabilized soil by column technique is evaluated. More importantly, in the third stage of this research, the constitutive model of dynamic behavior that more sophisticated for minimizing post-construction deformation will be formulated. In the final stage, by comparing the numerical analyses of behavior before and after treatment, the benefits of using this dirty gold in soil stabilization can be quantified in a rational manner, and compared to the alternative empirical relations. The outcomes of this proposed research will provide valuable information for geotechnical designers in designing cost-effective and well-performing stabilized soil to reduce the settlement of foundations, to prevent shear deformation and also to mitigate liquefaction during earthquake. Furthermore, in line towards achieving the status of green environmental policy, the innovation of using OPFA in the field of ground improvement will encourage geotechnical researchers in Malaysia to investigate usage of other agro-wastes.

Hypothesis:

Hypothetically, the large amount of amorphous silica in POFA potentially contributes to the pozzolanic reaction during hydration, which results in cementitious compounds called calcium aluminate hydrates (CAH) and calcium silicate hydrates (CSH). These compounds are responsible for improving the engineering characteristics of soils that increase over time as the pozzolanic reaction develops.

Summary of literature review

Since engineering properties of soft clay soils are inferior to those of other soils, it is often viewed as problematic (Saride et al., 2003). The utilization of soft clay soils in tropical regions is currently low, although construction of them has become increasingly necessary because of economic reasons. These types of soils generally characterized by extremely high compressibility, high rates of creep, unsatisfactory strength characteristics, poor workability and bearing capacity (Jegandan

et al., 2010). Oil palm fuel ash (OPFA) is one of the most abundantly produced waste materials throughout the world which has a strong potential to be used in soft clay soil stabilization thanks to its high siliceous content. Researchers (Ahmad et al., 2008) reported that oil constitutes only 10% of the palm production, while the rest of 90% is the biomass. Despite efforts that have gone into finding reuse applications, considerable amounts of OPFA continue to require disposal through landfilling every year and governments need to allocate additional hectares of landfill for disposal and spends a ton of money for transporting this waste and maintenance functions (Sulaiman et al., 2011). However, by recycling this dirty gold, it can reduce the dumped waste in addition to make sure environmental sustainability. Implicitly, the revolution of oil fuel ash in the structural science has attracted a huge concentration, mainly due to its abundant accessibility, friendly environmental nature and low profitable commercial value. A review of literature shows that several investigators have taken initiative to usage OPFA as lightweight aggregate (Shafigh et al., 2011). Extensive research findings have highlighted that oil palm fuel ash usage, particularly in concrete, has significant environmental benefits (Alengaram et al., 2008; Hashim, 2009). However, a review of literature has revealed that not much effort has been made in the past to evaluate the efficacy of OPFA stabilized tropical soils, particularly in problematic soils which usually demands high quantities of stabilizer in order to reach satisfactory result (References presented in the next part).

Objectives:

The primary aim of this proposed research is to examine the geotechnical properties of oil palm fuel ash (OPFA) with enormous laboratory tests to analyse the effectiveness of using this dirty gold either solely or in combination with cement in soft clay soil stabilization. This part of the research focuses not only to identify the optimum percentage of soil and OPFA but also to understand the underlying mechanisms of stabilization. In addition, comparisons will be made with results from some previous investigations using other agro-wastes in ground improvement. The secondary aim is to develop an analytically sound and experimentally validated model representing the static and dynamic behaviour of OPFA treated soils for minimising post-construction deformation, with reference to differential settlement and lateral movement. To achieve these goals following objectives were devised:

- To examine the efficacy of oil palm kernel ash as a new stabilizer in soft clay soil stabilization.
- To determine the effect of optimum percentage of OPFA as partial or full substitution of cement on the deformation characteristics of the treated soil subjected to static and dynamic loads.
- To develop a constitutive model with inspiration from the laboratory observations to predict the deformation response of the OPFA stabilized soil under static and dynamic loading.
- To develop a numerical simulation that can correctly represent the effect of OPFA on the anisotropic soil behaviour, resilient modulus and shear strength under static and dynamic loading, as well as the ability to predict the long-term deformations of the OPFA treated soil.

Significance

These consequences modify many engineering characteristics of soil and therefore it is expected to (a) decrease settlement, (b) increase bearing capacity, (c) increase shear strength and undrained cohesion, (d) decrease permeability. All these stabilization mechanisms lead to a more stable and stronger soil mass capable of withstanding larger static and dynamic loads that can mitigate liquefaction. Furthermore, utilizing of this dirty gold as partial or full substitution of known conventional additives such as cement in ground improvement can be effective not only for reducing the energy consumption of conventional additives but also can be useful with respect to reducing the waste disposal volume.

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